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Existing Traffic Safety Problems of Expressways in China

Jianjun Zhang[a,b,*]

[a]*Research Institute of Highway, Ministry of Transport, No. 8 Road Xitucheng, Haidian District, Beiing, 100088, P. R. China*
[b]*Key Laboratory for Road Safety Technology, Ministry of Transport, No. 8 Road Xitucheng, Haidian District, Beiing, 100088, P. R. China*

Abstract

Expressways have played an increasingly important role in the economic development in China. Although the accident rate and fatality rate are declining, and expressways have an advantage compared with other highways in safety, the traffic safety situation is still unoptimistic. The fatalities are growing, and the proportion of fatalities is still high. The existing safety-related problems are analyzed in this paper. Crossing-median-barrier accidents and run-off-road accidents, safety management issues of special sections, efficiency and safety issues, and congestions issues need to be solved. Solutions of these problems should depend on the further development of expressways, and the traffic safety should be paid more attention in the further development. Meanwhile, solutions of these problems will help to promote the sustained, rapid and healthy development of expressways.

Keywords: Expressway; traffic safety; accident rate; fatality rate; rear-on collision; head-on collision

1. Introduction

By the end of 2011, the mileage of expressways open to traffic reached 84,946 kilometers, the expressway network density reached 0.88 kilometers per 100 square kilometers (Highway Bureau, Ministry of Transport, China, 2012). And the fast, safe, and efficient expressway network was initially built. Currently, the important role of expressways in the China's national economy is growing. Although the expressways accounted for only 2.07% of the total highway mileage by the end of 2011, the expressways bear about one-third of the country's passenger and freight turnover and 70% of the traffic volume (Shang, 2012). In 2011, the annual average daily

* Corresponding author. Tel.: +86-010-82013867; fax: +86-010-62370567.
E-mail address: jj.zhang@rioh.cn

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travelled reached 1.60897 billion vehicle kilometers (equivalent standard passenger cars), a 164.58% increase over 2004 (Comprehensive Planning Division, Ministry of Transport, China, 2012).

In recent years, the accident rate and fatality rate of the accidents on expressways have declined, and have a safety advantage compared with the other highways (Zhang, 2012). With the growing of the mileage and the vehicle's kilometers traveled, the fatalities is gradually increasing, and the proportion of the fatalities accounted for the total road accidents is over 10%. It can be predicted that the fatalities and the proportion of the fatalities will continue to increase with the continuous strengthening of the role of the expressways in the integrated transportation system. There is still a large gap on the accident rate and the fatality rate of expressways' accidents compared to the traffic safety advanced countries. The traffic safety situation of expressways is still unoptimistic. Meanwhile, there are several safety-related problems and these problems restricted the further improvement of the traffic safety of the expressways.

2. Existing major safety-related problems

2.1. Crossing-median-barrier accidents and run-off-road accidents

From 2005 to 2011, 40 devastating accidents with over ten fatalities in one accident happened on expressways, resulting in 726 people died and 770 people injured, and accounting for 17.78%, 20.89%, and 24.44% respectively of the total of devastating accidents with over ten fatalities in one accident (Zhang, 2012). Of which, 17 accidents were rear-end accidents, 16 accidents were run-off-accidents, and 10 accidents were head-on accidents. Some accidents have several accident patterns.

The operating speed of vehicles on expressways is high, but there is big speed difference among different vehicles. Inadequate safety distance can easily result in rear-end accidents. The rear-end accidents are the most common pattern of the expressways' accidents in many countries. Many expressways in China have high embankment, and high slope. The run-off-road accidents exacerbate the severity of the accidents. The head-on collisions are mainly caused by the vehicles that enter the opposite lane due to various reasons and collided with the normally running vehicles in the opposite lance.

The reasons of crossing-median-barrier accidents and run-off-road accidents are diverse. This is one of the important reasons that the traffic safety facilities of some sections cannot be effectively matched with the existing vehicle operating conditions. The Design Specification of Highway Traffic Safety Facilities (JTG D81-2006, referred to as the D81 specification) came into effect on September 1, 2006, replacing the Design and Construction Technical Specification of Expressway Traffic Safety Facilities (JTJ 074-94, referred to as the 074 specification). Compared with the 074 specification, the D81 specification further clarifies the crashworthiness of highway barriers, adjusts and expands the crashworthy level of barriers, and makes the large modifications to the setting principles of kinds of barriers, shown in Table 1 (Ministry of Transport, China, 1994, 2006). However, more than 41 thousand kilometers of expressways was open when the D81 specification came into effect in 2006. Although the traffic safety facilities of these expressways met the original design specification requirements, but the existing traffic safety facilities cannot meet the demand of vehicles' safety traffic with the change of road environments. This is to some extent lead to the crossing-median-barrier accidents and run-off-road accidents. Therefore, it is very urgent to update and upgrade the traffic safety facilities of these sections.

2.2. Safety operation and management problems of special sections

In recent years, there has been the high incidence of serious accidents on the continuous long and steep downgrades of expressways. The problem is more prominent with the highway construction further into the mountain areas and the increasingly prominent trend of the large trucks. As one of engineering measures preventing the accidents caused by the brake failure because of continuous braking in the continuous long and

steep downgrades, emergency escape ramps have been developed rapidly in China since the first emergency escape ramps was open in 1998. Currently, more than two-third provinces have built at least one emergency escape ramp, and more than 300 emergency escape ramps are opening, and play a positive role in preventing the serious accidents in the continuous long and steep downgrades. However, due to no guide of the specifications or standards, the emergency escape ramps have different styles and different construction standards. Part trucks with brake failure entered into the emergency escape ramps still cannot escape the doom. In fact, the emergency escape ramps are not a complete and fundamental solution to the traffic safety problem of the continuous long and steep downgrades.

Table 1. Regulations of the crashworthiness of barriers in D81 and 074 Specification

D81 Specification				074 Specification			
Crashworthy Level	Collision Conditions			Crashworthy Level	Collision Conditions		
	Collision Speed (*km/h*)	Vehicle Mass (1000*kg*)	Collision Angle (°)		Collision Speed (*km/h*)	Vehicle Mass (1000*kg*)	Collision Angle (°)
B	100	1.5	20	A, Am	60	10	15
	40	10	20				
A, Am	100	1.5	20	S, Sm	80	10	15
	60	10	20				
SB, SBm	100	1.5	20	PL1	80	2	20
	80	10	20		50	10	15
SA, SAm	100	1.5	20	PL2	70	10	15
	80	14	20				
SS	100	1.5	20	PL3	80	14	15
	80	18	20				

The highway construction is extending into the mountain areas. The proportion of tunnels and bridges is getting higher and higher. In some mountain highway, the proportion of tunnels and bridges is even up to 80%. Continuous tunnel and long tunnels are not uncommon. The length of the Zhongnanshan highway tunnel is 18.02 kilometers, and the second longest highway tunnel in the world. Meanwhile, many world-class bridges have been built up in recent years. Hangzhou Bay Bridge is the longest bridge in the world with the total length of 36 kilometers, and the main span of Sutong Bridge is 1,088 meters, is the longest span of the cable-stayed bridge.

With the development of long tunnels, increase of traffic density and vehicles' speed, the long tunnels face the increasing the operation safety test. Long distance and complex weather conditions are the characteristics of the bridges crossing rivers or seas. Minimize or eliminate all kinds of accidents is the safety operation and management requirements of these bridges.

2.3. Traffic efficiency and safety

Expressways in China have made great achievements. Currently, the mileage of expressways exceed that of the US, making it the world's longest. However, compared to the United States and other developed countries, there is still a large gap on the breadth and depth of expressway's development. By the end of 2011, expressway network density was 0.88 kilometers per one hundred square kilometers, while the United States was 0.95, Japan 1.61, the United Kingdom 1.47, France 1.99, Germany 3.1 and Italy 2.43 (Transport Planning and Research Institute, Ministry of Transport, China, 2004). Meanwhile, most of expressways in China are four lanes for two directions. By the end of 2011, 81.92% expressways are four lanes for two directions, 14.91% for six lanes, and

only 3.16% for eight lanes, shown in Fig 1 (Highway Bureau, Ministry of Transport, China, 2012). In some sections with four lanes for two directions, once the slow-moving vehicles occupy the inside lane for a long time, it can easily result in the backlog of vehicles, the low traffic efficiency and the low level of traffic services. Meanwhile, due to the large difference of the operating speed between the large vehicles and small vehicles, the rear-end collisions are prone to happen. This has an adverse impact on traffic safety of expressways.

Currently, in addition to the rapid development of new expressways, China is ushering the peak of the rehabilitation and expansion of the four-lane expressways built in the early. Different from the construction of new expressways, it is necessary that expressways are open to traffic without interrupting the normal traffic requirements during the construction of the renovation and expansion. Open to the traffic and construction safety are one of the important contents of the project management of the expressways' rehabilitation and expansion. This proposes the higher requirements to the traffic organization and management during the construction of the renovation and expansion. Otherwise, it can easily lead to road accidents.

2.4. Congestion

In recent years, traffic congestion has been common in some sections of expressways, especially around the large cities. The main reasons of traffic congestion includes: the surge traffic, frequent traffic accidents, maintenance and reconstruction construction, wrong traffic organization and management, and bad weather, etc. (Wu, 2012).

In the eastern region of China, the traffic volume of some expressways has far exceeded the design capacity. This is the main reason of the congestion of these sections. During the National Day holiday in 2011, the first toll-free holiday policy have implemented in China. The policy, which allows free passage of passenger cars with seven seats or fewer on toll highways, bridges and tunnels during Spring Festival, Tomb-Sweeping Day, Labor Day and National Day (Ministry of Transport, China, et.al, 2012). Due to the surge traffic, the congestion hit 24 expressways in 16 provinces during the first day of the National Day holiday in 2011.

The maintenance and renovation and expansion construction can easily lead to congestion. On July 18, 2009, the massive vehicles jammed up to 40 kilometers in the Tianjin sections of the G25, Changchun to Shenzhen Expressway, due to the construction and intermittent release (Highway Network Management and Emergency Disposal Center, MOT, China, 2010).

The bad weather, such as fog, snow, frost, heavy rain, is one of the important causes of congestion. Large dynamic performance difference among vehicles, and the slow-moving vehicles occupy the inside lane for a long time, it can easily result in the jam of vehicles. Accidents can easily result in the congestion and even traffic disruption. Currently, the electronic toll collection and the networked toll collection has not been large-scale application. This leads to be prone to congestion in the toll stations.

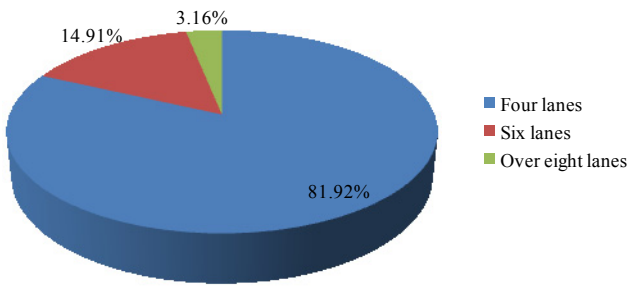

Fig. 1. Lane distribution of expressways in China in 2011 (Source: Highway Bureau, Ministry of Transport, China, 2012)

3. Ways to solve the problems

About 85,000 kilometers national expressways were promulgated in the National Expressway Network Plan in 2004 (Ministry of Transport, China, 2005). By the end of 2011, 84,946 kilometers expressways were built, including 3,631 kilometers national expressways, and accounting for 74.86% of the objective of the National Expressway Network Plan. Over one-fourth of the objective has not been built. Moreover, the 12th Five-year Plan for the National Economic and Social Development of the People's Republic of China proposed that the transportation should make the moderate advance development (The State Council, China, 2011). Therefore, it can be predicted that the expressways are still in the concentrated period of construction during a long period of time. The above-mentioned problems will become more prominent with the further development of the expressways. Need to plan ahead, and take appropriate measures to resolve the problems at present. In fact, the key to solving the above problems is focused on two aspects. The first is the development, and relying on the further development of expressways to solve the above problems. The second is that the traffic safety needs to be paid more attention to during the development.

The expressway construction in China started 25 years ago. There are traffic congestion due to the excessive traffic volume and frequent accidents on some expressways constructed early. These expressways need to the renovation and expansion construction. Meanwhile, the expressways will play an increasingly important role in the integrated transportation system with the expressway network further show. The goal of the National Expressway Network Plan will be fully completed in the several years. To promote the further development of expressways, the National Expressway Network Plan need to be timely revised. The new goals, tasks of expressway construction and development in the new condition need to be formulated.

The safety-related problems should be paid more attention to in the expressway construction. As to the crossing-median-barrier accidents and run-off-road accidents, the expressways built before the D81 specification came into effect should be upgraded to ensure the traffic safety facilities to match the new changes of the existing road traffic environment. As to the safety operation and management problems of special sections, the research should be strengthened and the countermeasures should be proposed.

In the new situation of the initial shape of expressway network, the operation and management of expressway network should be strengthened to improve the public service capacity and operational benefits. The emergency management during the major holidays, large traffic volume, and major meteorological disasters should be strengthened to enhance the emergency management level and capacity.

4. Conclusions

Although the accident rate and fatality rate is declining, and have the safety advantage compared with the other highways, the traffic safety situation is still unoptimistic. The fatalities are growing, and the proportion of the fatalities is higher. The crossing-median-barrier accidents and run-off-road accidents, the safety management issues of special sections, the efficiency and safety issues, and congestions issues need to be solved. The solution of these problems depends on the further development of the expressways, and the traffic safety should be paid more attention to during the further development of the expressways. Meanwhile, the solution of these problems will help to promote the sustained, rapid and healthy development of expressways.

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